Space Weather Technical Forecast

Issued on Monday, 23 January 2023 at 01:25 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: R1/R2 Radio Blackouts likely throughout. Chance of G1/Minor Geomagnetic Storms 23rd & 24th.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate during the past 24 hours, with two M-class flares observed from AR3190 and AR3194. The largest was a M2.7 flare observed at 22/1701 UTC from AR3194 in the Southwest. There are currently nine sunspot regions on the visible disc. Most sunspot regions continue to evolve slowly, with AR3190 remaining the largest and most complex region on the visible disc, with a delta spot located to the north of the large main spot. AR3194 is the other notable sunspot at present, with a small delta spot in the trailing portion of the group and showing recent slight growth. Other sunspot regions are small, simple and appear to be relatively stable at this time.

Solar Wind / Geomagnetic Activity: Solar winds, as measured at ACE, have been indicative of weak and waning coronal hole fast wind effects. Wind speeds were slightly elevated, around 420-480 km/s. Density was predominantly at average levels. The IMF has been weak, but on a slight increasing trend, with a peak of 7 nT. The north-south component (Bz) was also weak throughout, with periodic fluctuations between +6/-6 nT. The phi angle was largely positive (towards the sun). Geomagnetic activity was Quiet to Unsettled (Kp 0-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 has been at Background levels throughout. High energy electron flux (greater than 2 MeV) has been at background to moderate levels. The 24-hour integrated electron fluence stayed well below the Active threshold on a slowly increasing trend, with 7.7e6 integrated pfu observed at 22/0001 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to continue Moderate, with a very slight chance of reaching High levels over the next four days. There are numerous candidate regions on the disc for significant flares, however, the most capable regions at this time are AR3190 and 3194.

Solar Wind / Geomagnetic Activity: Solar wind speeds expected to ease initially as we exit the fast wind of CH68/+. Enhancements are considered likely during 23rd and 24th due to a number of possible CME arrivals and later the arrival of the fast wind from CH69/+, perhaps with speeds of 550-600 km/s at times. Generally Quiet geomagnetic activity is expected initially, with a chance of Active to G1/Minor storm intervals later day 1 and into day 2 (23rd and 24th) due to potential CME arrivals and later the HSS of CH69. These effects should start to start to wane day 3 and into day 4 (25th & 25th), though with lower than average confidence.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES-16 is likely to remain at predominantly background levels, but with a slight chance of reaching S1 or greater through the period.

Electron flux should remain at background to moderate levels, although, with a chance of rising to high during the diurnal peaks. Possible CMEs and CH HSS on the 23rd and 24th may act to redistribute or suppress the electron fields, therefore reducing the risk of Active electron fluence.

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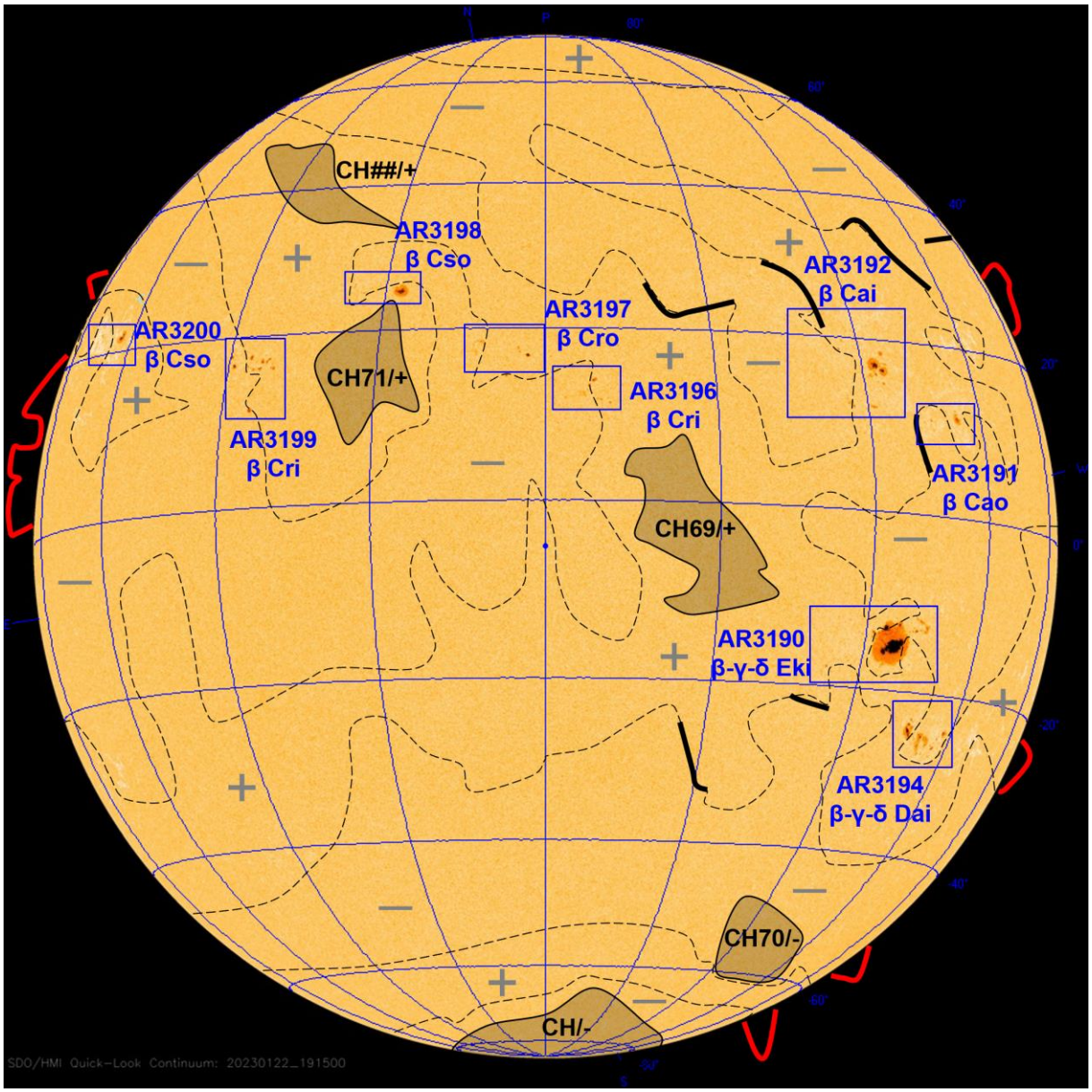
By 25th and 26th, as geomagnetic effects likely subside, there is an increasing chance of high electron flux occurring. Electron fluence is expected to stay below the Active threshold through the period. Perhaps with a rising trend towards the end of the period.

Figure 1. Solar Analysis Valid 22/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Met Office Space Weather Technical Forecast

Geomagnetic Storms:

Earth is currently in a weak HSS from CH68, the effects of which will gradually wane through day (23rd).

A number of CME's may effect Earth on the 23rd and 24th. The first from a faint halo signature associated with a flare from the NE on 19th. The second from a large, bright filament eruption from the SW on 20th. Shortly after this a flare originating from nearby AR3190 gave a mainly southward directed partial halo CME. All three could affect Earth, with somewhat uncertain geomagnetic effects as all are low confidence to affect Earth.

Large CH69 located west of the solar meridian is likely to connect with Earth on Day 3 (24th). This feature did not appear on previous rotation, therefore persistence is considered poor guidance. Speeds of around 550 km/s (elevated) could be expected with this feature.

Generally Quiet geomagnetic activity is expected initially, with a chance Active to G1/Minor storms later day 1 and into day 2 (23rd and 24th) due to potential CME arrivals and later the HSS of CH69. These effects should start to start to wane day 3 and into day 4 (25th & 25th), though with lower than average confidence.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	50	40	20	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
20/0940	Full	Filament eruption	NE	500 km/s	23/0900 UTC	Very faint, low confidence
20/1847	Partial	Filament eruption	SW	770 km/s	23/1200 UTC	Possible glancing blow. Medium confidence.
20/2222	Partial	Flare	AR3190 (SW)	450 km/s	24/1800 UTC	Possible glancing blow. Low confidence.

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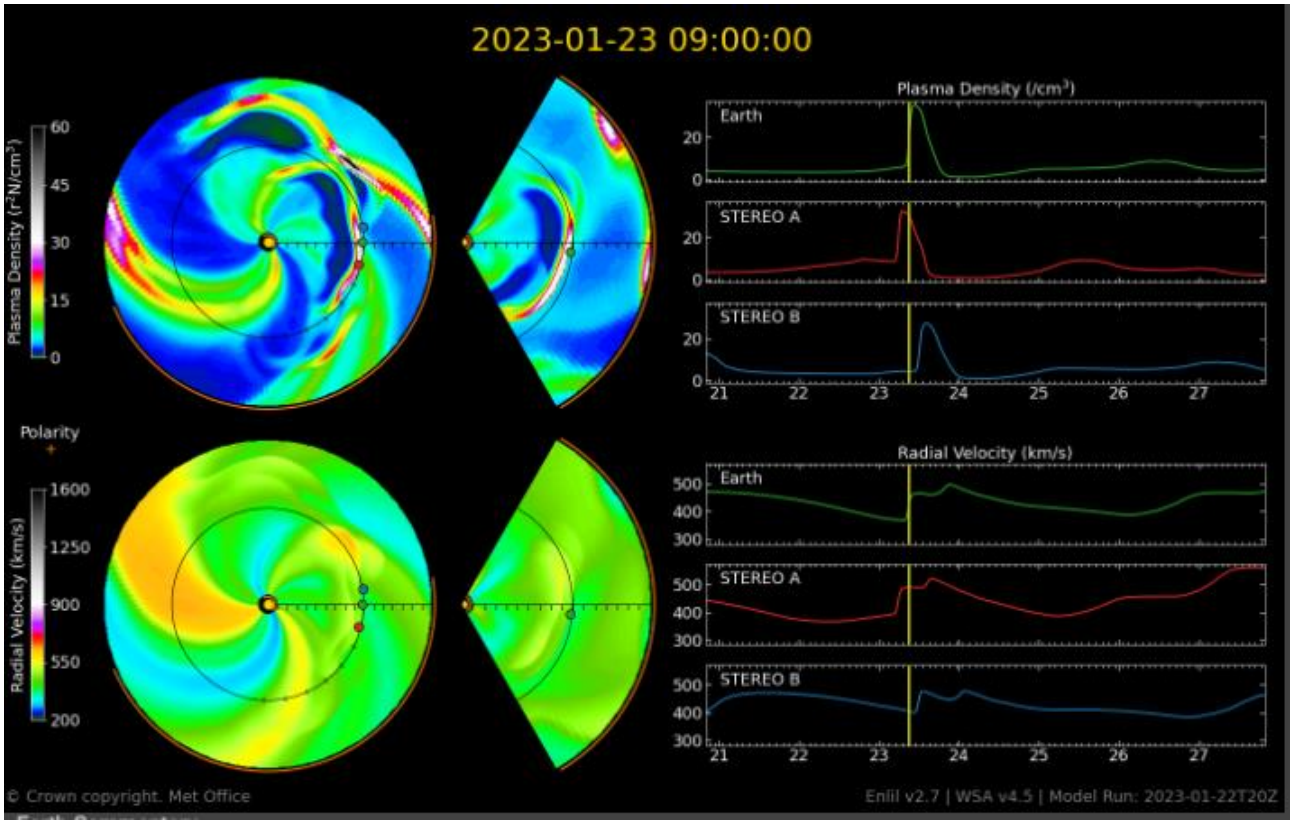
Figure 2: MOSWOC ENLIL



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Radio Blackouts - X-Ray Flares:

Solar activity has been Moderate during the past 24 hours, with two M-class flares observed from AR3190 and AR3194. The largest was a M2.7 flare observed at 22/1701 UTC from AR3194 in the Southwest.

Solar activity is expected to continue Moderate, with a very slight chance of reaching High levels throughout as the most complex regions continue to rotate west.

There are currently nine sunspot regions on the visible disc. Most sunspot regions continue to evolve slowly, with AR3190 remaining the largest and most complex region on the visible disc, with a delta spot located to the north of the large main spot. AR3194 is the other notable sunspot at present, with a small delta spot in the trailing portion of the group and showing recent slight growth. Other sunspot regions are small, simple and appear to be relatively stable at this time.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	60	60
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: 24 hour X-Ray Trace

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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux is currently at background levels.

While no recent S1+ events have been observed at GEO, the elevated number of front-sided groups dictates an elevated risk. AR3190 especially, contributes most of the risk as it continues to rotate westward into a more geo-effective sector. As such, a slight chance of S1 or greater continues through the four day period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

Electron flux should remain at background to moderate levels, although, with a chance of rising to high during the diurnal peaks. Possible CMEs on the 23rd and 24th may act to redistribute the electron fields, therefore reducing the risk of Active electron fluence, as will the onset of the HSS from CH69, expected on 24th. By 25th and 26th, as geomagnetic effects likely subside, there is an increasing chance of high electron flux occurring.
Electron fluence is expected to stay below the Active threshold through the period. Perhaps with a rising trend, as HSS and CME effects begin to wane. The MOSWOC REFM model is considered as a good overall trend for the four day period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	5	20	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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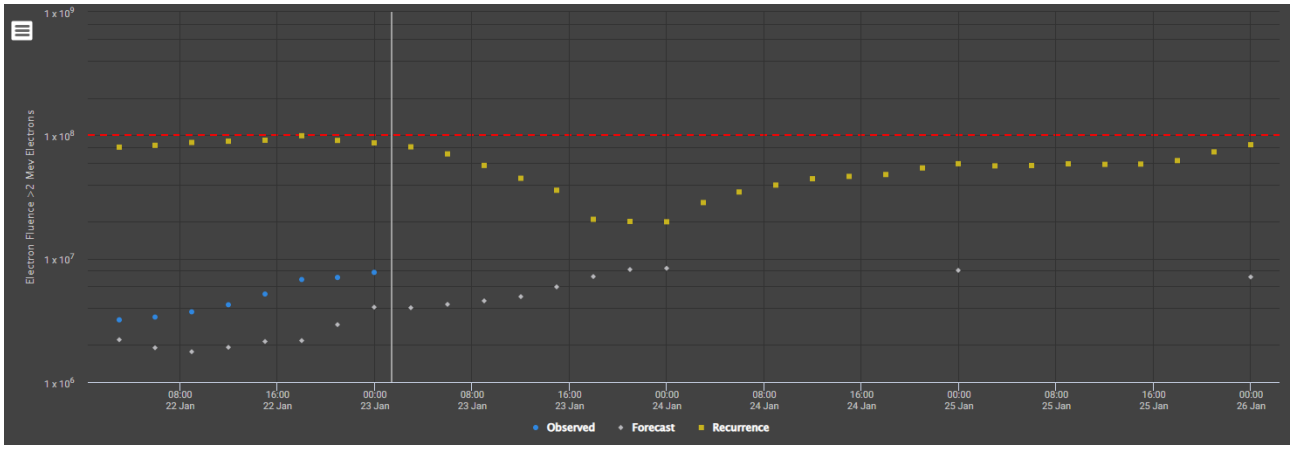
Figure 4: MOSWOC REFM integrated fluence.



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